

1 **CLAIM LISTING**

2
3 1. (Previously presented) A method of snapshot operation for a data storage
4 system with a first host that communicates with a cache memory, a source Virtual
5 Logical Unit Number (VLUN) containing source data and a target VLUN, preserving first
6 snapshot data of the source data at an instant in time and second snapshot data of the
7 source data at a later instant in time, wherein the first and second snapshots persist
8 concurrently, comprising:

9 generating first metadata to locate the first snapshot data and to indicate when a
10 data element of the first snapshot data is in the target VLUN; and

11 generating second metadata to locate the second snapshot data and to indicate
12 when a data element of the second snapshot data is in the target VLUN, wherein the
13 first and second metadata locate an original data element of the first snapshot data and
14 of the second snapshot data at the same address of the target VLUN.

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16 2. (Previously presented) The method of claim 1, wherein generating the first
17 metadata includes generating a first log file pointer to locate the original data element in
18 the target VLUN.

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20 3. (Previously presented) The method of claim 2, wherein generating the first
21 metadata includes changing a first bitmap to indicate the original data element has
22 migrated to the target VLUN.

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24 4. (Previously presented) The method of claim 1, wherein generating the
25 second metadata includes generating a second log file pointer to locate the original data
26 element in the target VLUN.

27
28 5. (Currently amended) The method of claim 4, wherein generating the
29 second metadata includes changing a second bitmap to indicate the original data
30 element has migrated to the target VLUN.

1 6. (Previously presented) A snapshot system for a data storage system
2 including a first host that communicates with a cache memory, a source Virtual Logical
3 Unit Number (VLUN), a target VLUN, and metadata, comprising:

4 a source VLUN for active data;

5 a target VLUN to store migrated snapshot data;

6 first metadata to indicate when and to locate where the first snapshot of the
7 active data is in the target VLUN; and

8 second metadata to indicate when and to locate where second snapshot data of
9 the active data is in the target VLUN wherein the first metadata and the second
10 metadata indicate and locate a data element common to the first and second snapshot
11 data in the target VLUN, wherein the snapshot system preserves the active data of the
12 first snapshot while taking the second snapshot.

13
14 7. (Original) The snapshot system of claim 6, wherein the first metadata
15 includes a first log file pointer to locate the first snapshot data in the target VLUN and
16 the second metadata includes a second log file pointer to locate the second snapshot
17 data in the target VLUN.

18
19 8. (Original) The snapshot system of claim 6, wherein the first metadata
20 includes a first bitmap to indicate when the first snapshot data has migrated to the target
21 VLUN and a first log file to locate the first snapshot data in the target VLUN, and the
22 second metadata includes a second bitmap to indicate when the second snapshot data
23 has migrated to the target VLUN and a second log file to locate the second snapshot
24 data in the target VLUN.

25 9. (Previously presented) The snapshot system of claim 6, wherein a first
26 bitmap and a second bitmap indicate that the first snapshot data and the second
27 snapshot data have migrated to the target VLUN.
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1 10. (Previously presented) The snapshot system of claim 6, wherein a first
2 log file and a second log file locate the first snapshot data and the second snapshot
3 data that have migrated to the target VLUN.

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5 11. (Previously presented) The snapshot system of claim 6, wherein the first
6 metadata and the second metadata indicate some of the first and second snapshot data
7 remain in the source VLUN.

8
9 12. (Original) The snapshot system of claim 6, wherein the first metadata
10 indicates that the original data of the first snapshot is in the target VLUN and the second
11 metadata indicates that the original data of the second snapshot is in the source VLUN.

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13 13. (Previously presented) The snapshot system of claim 6, wherein a first
14 log file and a second log file each include a pointer identifying the address of the
15 common data element in the target VLUN.

16
17 14. (Previously presented) A method of destaging data of one or more
18 snapshots to maintain data consistency of original data between a cache memory and a
19 target Virtual Logical Unit Number (VLUN) of a data storage system, comprising:
20 reading bitmaps for all of the snapshots into a first host memory;
21 reading log files for all of the snapshots into the first host memory;
22 searching the bitmaps to identify snapshots that require the original data to be
23 destaged;
24 destaging the original data to an available location in the target VLUN;
25 updating each log file associated with the identified bitmaps by adding pointers to
26 the original data located in the target VLUN; and
27 updating each associated bitmap to indicate completion of the destage operation
28 to the target VLUN.
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1 15. (Original) The method of claim 14, further comprising searching the
2 bitmaps for the presence of original data in the target VLUN, determining the next
3 available target address for the next destage operation, checking the cache memory to
4 see if other original dirty data needs to be destaged to the target VLUN and if so,
5 identifying additional snapshots requiring original data to be destaged and if not, writing
6 updated bitmaps and log files to the target VLUN.

7
8 16. (Previously presented) The method of claim 14, further comprising writing
9 the log files and the bitmaps to the target VLUN, removing a dirty data designation for
10 the destaged original data still in the cache memory and sending a destage operation
11 complete status.

12
13 17. (Previously presented) A method of snapshot operation in a data storage
14 system in a first host that communicates with a cache memory, a source Virtual Logical
15 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:
16 receiving requests from an application to modify data in the cache memory;
17 writing the modified data to the cache memory;
18 destaging the original data to the target VLUN to preserve the original data of a
19 first snapshot and a second snapshot; and
20 updating the first and second metadata to locate the original data common to the
21 first and second snapshot in the target VLUN.

22
23 18. (Original) The method of claim 17, further comprising destaging the first
24 and second metadata to the target VLUN.

25
26 19. (Original) The method of claim 17, further comprising updating the first
27 and second metadata to indicate the presence of the destaged original data in the target
28 VLUN.
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1 20. (Original) The method of claim 19, further comprising destaging the first
2 and second metadata to the target VLUN.

3
4 21. (Original) The method of claim 17, further comprising destaging the
5 modified data in the cache memory to the source VLUN to maintain data consistency.

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7 22. (Currently amended) A method of snapshot operation in a data storage
8 system in a first host that communicates with a cache memory, a source Virtual Logical
9 Unit Number (VLUN), a target VLUN, a plurality of bitmaps, and a plurality of log files,
10 comprising:

11 receiving requests from an application to modify data in the cache memory;

12 writing the modified data to the cache memory;

13 destaging the original data to the target VLUN to preserve the original data of a
14 first snapshot and a second snapshot;

15 adding a pointer in a first log file to locate the original data in the target VLUN;

16 updating a first bitmap to indicate the presence of the destaged original data in
17 the target VLUN;

18 adding a pointer to the original data in a second log file to locate the original data
19 in the target VLUN; and

20 updating a second bitmap to indicate the presence of the original data in the
21 target VLUN.

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23 23. (Original) The method of claim 22, further comprising destaging the
24 modified data in the cache memory to the source VLUN to maintain consistency.

25
26 24. (Original) The method of claim 22, further comprising destaging the first
27 and second bitmaps and the first and second log files to the target VLUN.

1 25. (Currently amended) The method of claim 14, wherein the step of
2 searching the bitmaps to identify snapshots that require the original data to be destaged
3 occurs after the data storage system fails and includes reading a bitmap, wherein if the
4 ~~bitmaps contain~~ bitmap contains a value in a bit position ~~identifying~~ indicating that the
5 original data is dirty in cache memory, destaging the original data to the target VLUN,
6 and wherein if the bitmap contains an inverse value in the bit position ~~representing~~
7 indicating the presence of the original data in the target VLUN, not destaging the
8 original data.

9
10 26. (Previously presented) A method of snapshot operation for a data storage
11 system with a first host that communicates with a cache memory, a source Virtual
12 Logical Unit Number (VLUN) and a target VLUN, comprising:

13 generating first metadata to locate first snapshot data and to indicate when the
14 first snapshot data is in the target VLUN, wherein generating the first metadata includes
15 generating a first log file pointer to locate first snapshot data in the target VLUN; and

16 generating second metadata to locate second snapshot data and to indicate
17 when the second snapshot data is in the target VLUN, wherein the first and second
18 metadata locate the same data in the target VLUN, and wherein generating the first
19 metadata includes changing a first bitmap to indicate first snapshot data has migrated to
20 the target VLUN.

21
22 27. (Previously presented) A method of snapshot operation for a data storage
23 system with a first host that communicates with a cache memory, a source Virtual
24 Logical Unit Number (VLUN) and a target VLUN, comprising:

25 generating first metadata to locate first snapshot data and to indicate when the
26 first snapshot data is in the target VLUN; and

27 generating second metadata to locate second snapshot data and to indicate
28 when the second snapshot data is in the target VLUN, wherein the first and second
29 metadata locate the same data in the target VLUN, wherein generating the second
30 metadata includes generating a second log file pointer to locate second snapshot data

1 in the target VLUN, and wherein generating the second metadata includes changing a
2 second bitmap to indicate second snapshot data has migrated to the target VLUN.

3
4 28. (Currently amended) A snapshot system for a data storage system
5 including a first host that communicates with a cache memory, a source Virtual Logical
6 Unit Number (VLUN), a target VLUN, and metadata, comprising:

7 a source VLUN for active data;
8 a target VLUN to store migrated snapshot data;
9 first metadata to indicate when and to locate where ~~the~~ first snapshot data is in
10 the target VLUN, wherein the first metadata includes a first bitmap to indicate when the
11 first snapshot data has migrated to the target VLUN and a first log file to locate the first
12 snapshot data in the target VLUN; and
13 second metadata to indicate when and to locate where second snapshot data is
14 in the target VLUN, wherein the first metadata and the second metadata ~~to~~ indicate and
15 locate the same snapshot data in the target VLUN, and wherein the second metadata
16 includes a second bitmap to indicate when the second snapshot data has migrated to
17 the target VLUN and a second log file to locate the second snapshot data in the target
18 VLUN.

19
20 29. (Currently amended) A snapshot system for a data storage system
21 including a first host that communicates with a cache memory, a source Virtual Logical
22 Unit Number (VLUN), a target VLUN, and metadata, comprising:

23 a source VLUN for active data;
24 a target VLUN to store migrated snapshot data;
25 first metadata to indicate when and to locate where ~~the~~ first snapshot data is in
26 the target VLUN; and
27 second metadata to indicate when and to locate where second snapshot data is
28 in the target VLUN, wherein the first metadata and the second metadata ~~to~~ indicate and
29 locate the same snapshot data in the target VLUN, wherein the first metadata and the
30 second metadata indicate snapshot data ~~remain~~ in the source VLUN.

1 30. (Currently amended) A method of snapshot operation in a data storage
2 system in a first host that communicates with a cache memory, a source Virtual Logical
3 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:
4 receiving requests from an application to modify data in the cache memory;
5 writing the modified data to the cache memory;
6 destaging the original data to the target VLUN to preserve the original data of a
7 first snapshot and a second snapshot;
8 updating the first and second metadata to locate the original data in the target
9 VLUN; and
10 destaging the first and second metadata to the target VLUN.

11
12 31. (Previously presented) A method of snapshot operation in a data storage
13 system in a first host that communicates with a cache memory, a source Virtual Logical
14 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:
15 receiving requests from an application to modify data in the cache memory;
16 writing the modified data to the cache memory;
17 destaging the original data to the target VLUN to preserve the original data of a
18 first snapshot and a second snapshot;
19 updating the first and second metadata to locate the original data in the target
20 VLUN;
21 updating the first and second metadata to indicate the presence of the destaged
22 original data in the target VLUN; and
23 destaging the first and second metadata to the target VLUN.

24
25 32. (Previously presented) A method of snapshot operation in a data storage
26 system in a first host that communicates with a cache memory, a source Virtual Logical
27 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:
28 receiving requests from an application to modify data in the cache memory;
29 writing the modified data to the cache memory;
30 destaging the original data to the target VLUN to preserve the original data of a
first snapshot and a second snapshot;

1 updating the first and second metadata to locate the original data in the target
2 VLUN; and
3 destaging the modified data in the cache memory to the source VLUN to
4 maintain data consistency.